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RISK ASSESSMENT FOR 100 CONGRESS AVENUE
BUILDING SITE, AUSTIN, TEXAS

Prepared Under

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LIST OF ACRONYMS

AIC	Acceptable Intake for Chronic Exposure
AIS	Acceptable Intake for Subchronic Exposure
ARAR	Applicable or Relevant and Appropriate Requirements
BCF	Bioconcentration Factor
DOH	Department of Health
CPF	Carcinogenic Potency Factor
LPC	Lincoln Property Company
PAH	Polynuclear Aromatic Hydrocarbons
USEPA	U.S. Environmental Protection Agency
WQC	Water Quality Criteria

SUMMARY

This report presents a human health and environmental risk assessment for contaminated soil remaining on Lincoln Property Company's (LPC's) Phase II site at 100 Congress Avenue in Austin, TX. The assessment is based on measured concentrations of contaminants in ground water collected from monitoring wells on the site. Low concentrations of toxic metals, cyanide and organic compounds are present in the ground water, apparently remaining from a coal tar body and contaminated soil which have been removed from the site. Some contaminated soil remains on site, which may be contributing to measured ground-water concentrations of contaminants.

An analysis of site and surrounding conditions indicates that no direct exposures (e.g., via inhalation or dermal contact) to contamination remaining on the Phase II site are expected to occur because of the clean fill cover. Because no toxic contaminants from the Phase II site show up in the effluent from the Phase I Building treatment system, no exposures, and consequently no risks, are expected via effluent discharge to Town Lake. Only one exposure pathway is likely to present potential health and environmental risks from soil contamination at the site. This is movement of a contaminated ground-water plume into Town Lake and subsequent exposure of fish and humans catching and ingesting contaminated fish. Estimates of human health risks associated with this exposure pathway are developed in the report.

Results of the risk assessment for the Town Lake exposure pathway indicate no noncarcinogenic human health (ingestion of contaminated fish) or environmental risks using worst case assumptions. Worst case calculated carcinogenic risks associated with ingestion of contaminated fish are below levels set as acceptable by the U.S. Environmental Protection Agency, so no additional remedial action is required at this site.

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1.0 INTRODUCTION

1.1 Background

Lincoln Property Company (LPC) has completed construction of a building on its 100 Congress Avenue site in the Central Business District of Austin, Texas. A second building is planned as Phase II of the site's development. Construction of the second building is planned to begin within five years.

A coal tar body and subsurface hydrocarbon contamination were discovered on the Phase II site (the site) during construction of the existing building (Radian 1986a). A coal gasification plant which operated on the site from 1877 until 1928 is considered to be the source of these materials. The coal tar body and some contaminated soil were removed and sent to an approved landfill as part of the first phase of the Closure Plan approved by the Texas Department of Health (DOH) for the site. Some remaining soil is contaminated with toxic metals, cyanide and organic compounds (including polynuclear aromatic hydrocarbons (PAHs)). The LPC plans to remove all remaining contaminated material from the site within five years of the date of approval of the Closure Plan for the site, unless amended (Radian 1986b).

1.2 Purpose of This Report

The purpose of this report is to provide an evaluation of potential human health and environmental risks associated with leaving the contaminated on-site material for a five-year period. The risk assessment approach used for this evaluation is consistent with the U.S. Environmental Protection Agency's (USEPA's) guidance for risk and endangerment assessments at hazardous waste sites (ICAIR 1985, USEPA 1986, Schultz et al. 1986).

The objective of this evaluation is to identify possible effects of the current soil contamination on potentially exposed populations if no action is taken to remediate conditions at the Phase II site within the next five years. The results of this evaluation will be used to determine the extent to which conditions at the site must be remediated (i.e., possible removal of remaining contaminated soils) prior to the planned date.

Results of two recent ground-water monitoring studies conducted at the Phase II site provide the basis of this risk assessment (Radian 1987b, Law 1987).

The evaluation consists of the following four steps:

1. Contaminant Analysis

- Determination of mean and maximum concentration of contaminants of concern in ground water on site

2. Exposure Assessment

- Identification of potential exposure routes
- Estimation of potential exposure point concentrations
- Estimation of potential subchronic and chronic human intakes

3. Toxicity Assessment

- Identification of applicable or relevant and appropriate requirements (ARARs)
- Identification of critical toxicity values

4. Risk Characterization

- Comparison of potential exposure point concentrations to ARARs
- Integration of estimated potential human intakes with critical toxicity values
- Characterization of uncertainties

The results of this evaluation are summarized in this report. This report is divided into seven sections in addition to this Introduction:

- 2.0 Contaminant Analysis
- 3.0 Exposure Assessment
- 4.0 Toxicity Assessment
- 5.0 Risk Characterization
- 6.0 Uncertainties
- 7.0 Conclusions
- 8.0 References

2.0 CONTAMINANT ANALYSIS

Radian (1987b) monitored ground water at an existing well on the Phase II site to characterize impacts of soil contamination. Samples collected at weekly intervals over a three-week period were analyzed for both toxic and conventional pollutants (Table 2-1).

Law Engineering Testing Company (Law) (Law 1987) monitored ground water in the existing well and four additional wells on site during April and May, 1987 (Table 2-2). In addition to analyzing samples from four new ground-water monitoring wells, Law analyzed for total metals instead of dissolved metals. Radian's measurements of dissolved metals are assumed to be more representative of levels expected in water which could move off site to potential exposure points. Measurements of total metals are more rigorous (i.e., include metals adsorbed to particulate matter) and over estimate the concentration of metals expected in ground water likely to move off site. The results of total and dissolved metals analyses of ground-water samples are not directly comparable and cannot be combined. Therefore, the dissolved measurements reported by Radian (1987b) are selected for analysis.

The organic analyses performed on the two sets of samples are assumed to be comparable and can be combined to develop a best estimate (arithmetic average) of organic analyte concentrations.

Toxic compounds reported at levels above the lowest "less than (<)" value (assumed to be reported analytical detection limits) are used as the basis for evaluating human health and environmental effects of soil contamination. The mean and maximum concentrations of these compounds in ground water are listed in Tables 2-3 and 2-4. In the case where both positive hits and "less than (<)" values were reported for a compound, the listed "less than" value was used (e.g., <0.01 µg/L is assumed to be 0.01 mg/L) in calculating the mean ground-water concentration. This procedure yields a worst case estimate of the concentration of the compound in ground water, since the alternative of using zero for the "less than" value in calculating the mean is more likely to underestimate the true value. Insufficient information is provided on analytical and quality control performance in the Radian (1987b) reports to select a value in between zero and the listed value for use in calculating mean concentrations. Law (1987) did not report "<" values in its summary of analytical results table, so they were not included in this assessment.

In addition to compounds reported as not detected, those with no positive hits (i.e., all values at all locations listed in Radian (1987b) as "less than (<)" were assumed to be not detected. Data on phenol reported by Radian was excluded from this risk assessment because of the note in the laboratory report (Appendix A of Radian Report) that insufficient sample volume was available for analysis.

Table 2-5 presents average and maximum values for the combined organic analysis results (Radian 1987b, Law 1987). These data plus metals and inorganic data from Radian (1987b) are used for the exposure and risk assessment presented in Section 3.0 and 5.0.

TABLE 2-1 PARAMETERS REPORTED BY RADIAN (1987b) IN ANALYSES OF
GROUND-WATER SAMPLES FROM THE PHASE II SITE

Metals (Dissolved)

Arsenic (As)
Barium (Ba)
Boron (B)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Lead (Pb)
Manganese (Mn)
Mercury (Hg)
Nickel (Ni)
Selenium (Se)
Silver (Ag)
Zinc (Zn)

Halogenated Organic Compounds

Volatile Aromatic Hydrocarbons

Benzene
Chlorobenzene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Ethylbenzene
Toluene

Other Water Quality Parameters

BOD5
Carbon, Total Organic
COD
Chloride
Cyanide
Oil and Grease
pH
Phenols
Phosphorous, Dissolved Ortho
Phosphorous, Total
Residue, Filterable (TDS)
Residue Non-Filterable (TSS)
Solids, Settleable
Sulfate
Formaldehyde

Polynuclear Aromatic Hydrocarbons

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(ghi)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-c,d)pyrene
Naphthalene
Phenathrene
Pyrene

TABLE 2-2 PARAMETERS REPORTED BY LAW (1987) ANALYSIS OF GROUND-WATER
SAMPLES FROM THE PHASE II SITE

Metals (Total)

Arsenic (As)
Barium (Ba)
Boron (B)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Lead (Pb)
Manganese (Mn)
Mercury (Hg)
Nickel (Ni)
Selenium (Se)
Silver (Ag)
Zinc (Zn)

Other Water Quality Parameters

Carbon, Total Organic
Chloride
Cyanide
Formaldehyde
Orthophosphate
Phenolics
Phosphorous
Sulfate

Volatile Aromatic Hydrocarbons

Benzene
Ethylbenzene
Toluene
Xylene

Acid Extractable Hydrocarbons

Phenol
2,4-Dimethylphenol

Base/Neutral Extractable
and Polynuclear Aromatic Hydrocarbons

Acenaphthene
Acenaphthylene
Di-N-butylphthalate
Fluorene
Naphthalene
Phenanthrene

TABLE 2-3 SUMMARY OF CONTAMINANT CONCENTRATIONS REPORTED BY
 RADIAN (1987b) IN GROUND WATER ON THE PHASE II 100 CONGRESS
 AVENUE SITE^(a)

Contaminant	Sample Concentration, mg/L ^(b)	
	Mean ^(c)	Maximum
1. METALS/INORGANIC		
Arsenic	0.01	0.02
Barium	0.34	0.37
Boron	0.38	0.40
Cyanide	0.057	0.12
Manganese	0.52	0.11
Mercury	0.002	0.003
Zinc	0.01	0.02
2. VOLATILE AROMATIC HYDROCARBONS		
Benzene	0.096	0.118
Ethylbenzene	0.041	0.06
Toluene	0.007	0.01
3. POLYNUCLEAR AROMATIC HYDROCARBONS		
Acenaphthene	1.383	2.49
Acenaphthylene	0.963	1.11
Anthracene	0.04	0.05
Fluoranthene	0.037	0.06
Fluorene	0.17	0.21
Naphthalene	0.643	0.95
Phenanthrene	0.147	0.15
Pyrene	0.023	0.03

(a) See text for an explanation of reported laboratory analytical results used for the contaminant analysis.

(b) N = 3.

(c) Mean calculated by using all values preceded by a "<" (less than) symbol equal to the reported level (e.g., <0.01 mg/L is assumed to be 0.01 mg/L). This assumption is required for the worst case analysis.

TABLE 2-4 SUMMARY OF CONTAMINANT CONCENTRATIONS REPORTED
BY LAW (1987) IN GROUND WATER ON THE PHASE II
100 CONGRESS AVENUE SITE^(a)

Contaminant	Sample Concentration, mg/L	
	Mean ^(b)	Maximum
1. METALS (TOTAL) ^(c)		
Barium	98.20	128.00
Boron	0.38	0.68
Lead	0.06	0.10
Manganese	1.09	1.50
Nickel	0.07	0.08
Zinc	0.06	0.11
2. VOLATILE AROMATIC HYDROCARBONS ^(d)		
Benzene	2.33	7.80
Ethylbenzene	3.79	9.30
Toluene	2.76	7.70
Xylene	3.63	6.00
3. ACID EXTRACTABLE HYDROCARBONS ^(e)		
Phenol	1.10	1.10
2,4-Dimethylphenol	0.37	0.37
4. BASE/NEUTRAL AND POLYNUCLEAR AROMATIC HYDROCARBONS ^(f)		
Acenaphthene	0.020	0.020
Acenaphthylene	0.029	0.029
Di-N-butylphthalate	0.098	0.130
Fluorene	0.029	0.029
Naphthalene	10.00	18.00
Phenanthrene	1.51	3.00

(a) See text for explanation of reported laboratory analytical results used for the contaminant analysis.

(b) Mean calculated on basis of values reported in Table 2-7 of Law (1987).

(c) N=5.

(d) N=6, except for Xylene (N=3).

(e) N=1.

(f) N=1, except Di-N-butylphthalate (N=2), Phenanthrene (N=2) and Naphthalene (N=3).

TABLE 2-5 SUMMARY OF CONTAMINANT CONCENTRATIONS BASED ON COMBINED
RESULTS OF RADIAN (1987b) AND LAW (1987)

Contaminant	Sample Concentration, mg/L	
	Mean	Maximum
1. VOLATILE AROMATIC HYDROCARBONS ^(a)		
Benzene	1.59	7.8
Ethylbenzene	2.54	9.3
Toluene	1.84	7.7
Xylene	3.63	6.0
2. ACID EXTRACTABLE HYDROCARBONS ^(b)		
Phenol	1.1	1.1
2,4-Dimethylphenol	0.37	0.37
3. BASE/NEUTRALS AND POLYNUCLEAR AROMATIC HYDROCARBONS ^(c)		
Acenaphthene	1.043	2.49
Acenaphthylene	0.730	1.11
Anthracene	0.040	0.05
Di-N-butylphthalate	0.098	0.13
Fluoranthene	0.037	0.06
Fluorene	0.135	0.21
Naphthalene	5.322	18
Phenanthrene	0.692	3
Pyrene	0.023	0.03

(a) N=9, except for Xylene (N=3).

(b) N=1.

(c) N=4, except Anthracene (N=3), Di-N-butylphthalate (N=2), Fluoranthene (N=3), Naphthalene (N=6), Phenanthrene (N=5) and Pyrene (N=3).

3.0 EXPOSURE ASSESSMENT

The following assumptions were made in identifying potential exposure routes and characterizing contaminant transport off site.

1. Human exposure to contaminated soil or leachate on site will not occur prior to planned removal activities due to burial with clean fill. Because at least 10-30 feet of clean fill covers remaining contaminants (Radian 1987a) on the Phase II site, no exposure via direct contact or inhalation (air route) will occur.
2. All contaminated soil will be removed from the site within five years (Radian 1987a). The maximum period of exposure is five years.
3. The only possible movement of contaminants off site is by lateral ground-water transport. The direction and rate of flow is likely to vary over time due to relatively low hydrogeological gradients in ground water on the Phase II site (Radian 1987b). Although some unknown amount of contaminated ground water is expected to enter the sump and treatment system on the Phase I site, all flow is assumed to flow into Town Lake for the purpose of conducting a worst-case risk assessment. Ground-water flow across the site is estimated at 1,000 gal/day (Radian 1987b and Section 3.2 below). The distance the contaminated flow travels from the site to Town Lake is approximately 250 feet (Espey, Huston & Associates, Inc. 1986).
4. Radian (1987b) reports that some contaminants detected on the Phase II site are occasionally detected in the influent to the Phase I Building treatment system on the Phase I site. They also report that none of the toxic contaminants in the influent show up on treated effluent being discharged to Town Lake. Therefore, no exposures, and consequently, no risks are expected from contaminated ground water from the Phase II site treated and discharged by the treatment system on the Phase I site.

3.1 Potential Exposure Routes

The only potential exposure pathways from contaminants on site are via ground-water flow into Town Lake. The State of Texas designates Town Lake as being suitable for primary contact recreation, public water supply and high quality aquatic life habitat. Primary contact recreation is not allowed in Town Lake, for reasons other than water quality. Therefore, direct contact with lake water is not a potential exposure route.

A record of a telephone conversation between Mr. Robert Wallace (Radian Corporation) and Mr. Steve Guttruter (Texas Parks and Wildlife) on March 24, 1987 (Radian 1987b, Appendix B) indicates there are no drinking water intakes downstream of the site on Town Lake and further downstream on the Colorado River, at least as far as Bastrop, TX. Therefore, exposure via ingestion of contaminated drinking water is not expected to occur and the only potential

human exposure routes based on Town Lake's present use designations is ingestion of contaminated fish. The existing water supply intake in Town Lake is upstream of the point ground-water flow from the site is expected to enter Town Lake.

Dilution and fate processes are expected to lower instream concentrations from any pollutants discharged from the site at farther downstream drinking water exposure points.

The most probable populations at risk from exposure to contamination from the site entering Town Lake are resident fish populations and humans catching and eating fish from the Town Lake exposure point. An estimated 81,446 anglers may catch and ingest fish from Town Lake (telephone conversation between Mr. Robert Wallace (Radian Corporation) and Mr. Steve Gutruter (Texas Parks & Wildlife) on March 24, 1987 (Radian 1987b). Although data on resident fish species in Town Lake could not be obtained in time to include them in this risk assessment, consideration of U.S. Environmental Protection Agency (USEPA) water quality criteria for protection of freshwater aquatic life (Section 4.0) addresses risk to these populations.

3.2 Exposure Point Concentrations

Estimated exposure point concentrations were calculated for the contaminant plume, after mixing, in Town Lake from aquifer discharge concentrations using the relationship (Mills et al. 1985):

$$C(x) = \frac{C_u Q_u + C_w Q_w}{Q_u + Q_w}$$

where:

- $C(x)$ = Instream concentration, after mixing (mg/L)
- C_u = Upstream concentration (mg/L)
- Q_u = Upstream flow (cfs)
- C_w = Aquifer concentration (mg/L)
- Q_w = Aquifer discharge flow (cfs)

The estimated worst-case mean and maximum ground-water concentrations from Table 2-2 were used for C_w because of the proximity of the site to Town Lake. A background (i.e., upstream) concentration of 0 mg/L was assumed. The upstream flow in Town Lake was estimated to be 1,500 cfs. The estimated aquifer discharge flow (Q_w) into Town Lake was 0.0015 cfs. This flow is calculated as follows (Heath 1983):

$$Q_w = (k)(i)(b)(l)$$

where:

- Q_w = aquifer discharge flow (cfs)
- k = hydraulic conductivity (ft/sec)
- i = gradient (dimensionless)
- b = saturated aquifer thickness (ft)
- c = length of reach along stream (ft)

The estimated exposure point (i.e., instream) contaminant concentrations (mg/L) are presented in Table 3-1. It should be pointed out that this simplified, worst-case analysis assumes a constant release at the indicated mean levels (Table 3-1) over a 70-year exposure period. In reality, lower exposure levels are likely to occur over that time period.

3.3 Subchronic and Chronic Human Intake

Based on the estimated exposure point concentrations, potential subchronic (based on maximum exposure concentration over a short period of time) and chronic (based on mean exposure concentration over 70 years) human intake values for the contaminants at the site are calculated for the potential ingestion of contaminated fish from Town Lake. These potential intake values will be integrated with critical toxicity values during the risk characterization step of this assessment to yield an estimate of potential risk at the site.

Human intake values for the potential ingestion of fish are calculated as the product of the chemical specific bioconcentration factor (bcf), the exposure point concentration (subchronic and chronic) and a site-specific human intake factor for fish (USEPA 1986). For the purposes of this assessment, it was assumed all fish ingested (0.15 g fish/day/angler for the next 70 years (Radian 1987b, Appendix B)) by the potentially exposed population (81,446 anglers) come from Town Lake. This is a conservative (i.e., worst-case) assumption which will maximize the potential risk.

The estimated potential subchronic and chronic human intake values are presented in Table 3-2. Specific bcfs for barium, boron, cyanide, manganese, xylene, di-N-butylphthalate and 2,4-dimethylphenol are not provided by USEPA (1986). Therefore, these chemicals are not carried further through risk characterization.

TABLE 3-1 ESTIMATED EXPOSURE POINT CONCENTRATIONS

Chemical	Exposure Point ^(a) Concentration, mg/L	
	Mean	Maximum
1. METALS/INORGANIC		
Arsenic	1.0×10^{-8}	2.0×10^{-8}
Barium	3.4×10^{-7}	3.7×10^{-7}
Boron	3.8×10^{-7}	4.0×10^{-7}
Cyanide	5.7×10^{-8}	1.2×10^{-7}
Manganese	5.2×10^{-7}	1.11×10^{-6}
Mercury	2.0×10^{-9}	3.0×10^{-9}
Zinc	1.0×10^{-8}	2.0×10^{-8}
2. VOLATILE AROMATIC HYDROCARBONS		
Benzene	1.59×10^{-6}	7.8×10^{-6}
Ethylbenzene	2.54×10^{-6}	9.3×10^{-6}
Toluene	1.84×10^{-6}	7.7×10^{-6}
Xylene	3.63×10^{-6}	6.0×10^{-6}
3. ACID EXTRACTABLE HYDROCARBONS		
Phenol	1.1×10^{-6}	1.1×10^{-6}
2,4-Dimethylphenol	3.7×10^{-7}	3.7×10^{-7}
4. BASE NEUTRALS AND POLYNUCLEAR AROMATIC HYDROCARBONS		
Acenaphthene	1.04×10^{-6}	2.49×10^{-6}
Acenaphthylene	7.3×10^{-7}	1.11×10^{-6}
Anthracene	4.0×10^{-8}	5.0×10^{-8}
Di-N-butylphthalate	9.8×10^{-8}	1.3×10^{-7}
Fluoranthene	3.7×10^{-8}	6.0×10^{-8}
Fluorene	1.4×10^{-7}	2.1×10^{-7}
Naphthalene	5.32×10^{-6}	1.8×10^{-5}
Phenanthrene	6.92×10^{-7}	3.0×10^{-6}
Pyrene	2.3×10^{-8}	3.0×10^{-8}

(a) Exposure point defined as contaminant plume after mixing in Town Lake. Concentrations in the contaminant plume are estimated on the basis of procedures given in Mills et al. (1985).

TABLE 3-2 ESTIMATED SUBCHRONIC AND CHRONIC HUMAN DAILY INTAKE VALUES

Chemical	Total Estimated	
	Daily Intake, ^(a) mg/kg/day	
	Subchronic ^(b)	Chronic ^(c)
1. METALS/INORGANIC		
Arsenic	1.85×10^{-12}	9.24×10^{-13}
Mercury	3.46×10^{-11}	2.31×10^{-11}
Zinc	1.97×10^{-12}	9.87×10^{-13}
2. VOLATILE AROMATIC HYDROCARBONS		
Benzene	8.5×10^{-11}	1.73×10^{-11}
Ethylbenzene	7.3×10^{-10}	2.00×10^{-10}
Toluene	1.7×10^{-10}	4.10×10^{-11}
3. ACID EXTRACTABLE HYDROCARBONS		
Phenol	3.23×10^{-12}	3.23×10^{-12}
4. POLYNUCLEAR AROMATIC HYDROCARBONS		
Acenaphthene	1.26×10^{-9}	5.3×10^{-10}
Acenaphthylene	2.77×10^{-10}	1.8×10^{-10}
Anthracene	5.02×10^{-11}	4.0×10^{-11}
Fluoranthene	1.45×10^{-10}	8.94×10^{-11}
Fluorene	5.73×10^{-10}	3.80×10^{-10}
Naphthalene	3.97×10^{-10}	1.17×10^{-9}
Phenanthrene	1.70×10^{-10}	3.82×10^{-10}
Pyrene	1.90×10^{-10}	1.45×10^{-10}

(a) Human Intake Factor = Daily Intake From Ingestion of Fish.

(b) Subchronic Intake = (Short-term (Maximum) Concentration) x (Human Intake Factor) x (bioconcentration factor).

(c) Chronic Intake = (Long-term (Mean) Concentration x (Human Intake Factor) x (bioconcentration factor).

4.0 TOXICITY ASSESSMENT

The ARARs for comparison to exposure point concentrations in Town Lake are the following:

- USEPA's Ambient Water Quality Criteria (WQC) for the protection of human health from the ingestion of aquatic organisms
- USEPA's WQC for the protection of aquatic life

The ARARs available for the contaminants of concern are presented in Table 4-1. There are no applicable state standards for the contaminants of concern.

Table 4-2 presents critical toxicity values that used to characterize potential risks associated with the estimated human intake values. Three values that describe the degree of toxicity posed by a chemical are presented:

- the acceptable intake for subchronic exposure (AIS)
- the acceptable intake for chronic exposures (AIC)
- the carcinogenic potency factor (CPF)

The first two acceptable intake levels are used to evaluate noncarcinogenic effects. These values are derived by the USEPA from quantitative toxicological information available from studies in animals (or observations made in human epidemiologic studies) on the relationship between intake and effect. The AIS and AIC values are designed to be protective of sensitive populations; the CPF (equivalent to q_1^*) is an estimated upper 95% confidence limit of the carcinogenic potency of a chemical (USEPA 1986). Critical toxicity values for noncarcinogenic effects are available for six contaminants; CPFs are available for 3 of the 16 contaminants (USEPA 1986).

TABLE 4-1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Chemical	USEPA Water Quality Criteria, mg/L		
	Human Health ^(a)	Freshwater Aquatic Life	
		Acute	Chronic
1. METALS/INORGANIC			
Arsenic	1.75×10^{-5}	0.36	0.19
Cyanide	-(b)	0.022	5.2×10^{-3}
Mercury	$1.46 \times 10^{-4}(c)$	2.4×10^{-3}	1.2×10^{-5}
Zinc	-	0.18	0.047
2. VOLATILE AROMATIC HYDROCARBONS			
Benzene	0.04 ^(c)	-	-
Ethylbenzene	3.28 ^(c)	-	-
Toluene	424 ^(c)	-	-
3. ACID EXTRACTABLE HYDROCARBONS			
Phenol	769 ^(c)	-	-
4. BASE NEUTRAL AND POLYNUCLEAR AROMATIC HYDROCARBONS			
Acenaphthylene	3.11×10^{-5}	-	-
Anthracene	3.11×10^{-5}	-	-
Di-N-butylphthalate	154 ^(c)	-	-
Fluoranthene	0.054 ^(c)	-	-
Fluorene	3.11×10^{-5}	-	-
Phenanthrene	3.11×10^{-5}	-	-
Pyrene	3.11×10^{-5}	-	-

(a) Ingestion of organisms only. For carcinogenicity protection, except as noted.

(b) Not available.

(c) For toxicity protection.

TABLE 4-2 CRITICAL TOXICITY VALUES^(a)

Chemical	Oral Route Acceptable Intake, mg/kg/day		Cancer Potency Factor, (mg/kg/day) ⁻¹
	Subchronic (AIS)	Chronic (AIC)	
Arsenic	-	-	1.50 (A) ^(b)
Benzene	-	-	0.052 (A)
Di-N-butylphthalate	-	0.1	-
Ethylbenzene	0.97	0.1	-
Mercury	0.002	0.002	-
Toluene	0.43	0.3	-
Total PAHs ^(c)	-	-	11.5 (B2)
Xylenes	0.1	0.01	-
Zinc	0.21	0.21	-

(a) Source: USEPA 1986.

(b) Letter in parentheses refers to USEPA's weight-of-evidence associated with the classification of this chemical as a potential carcinogen.

(c) Value used to evaluate intake of eight PAHs in this study.

5.0 RISK CHARACTERIZATION

The estimated exposure point concentrations (Table 3-1) were compared to the ARARs (Table 4-1). If a contaminant concentration exceeds an ARAR then there exists a potentially unacceptable human health risk associated with that chemical under the specified exposure conditions.

None of the estimated exposure point concentrations exceed the USEPA WQC for the protection of human health or the EPA WQC for the protection of aquatic life. This analysis suggests that there are no health risks if aquatic organisms are ingested and no risks to aquatic life from the contaminant plume in Town Lake. Potential noncarcinogenic and carcinogenic risks are further characterized using estimated intake levels in the following sections.

5.1 Noncarcinogenic Risk Characterization

Potential risks from the noncarcinogenic effects of chemicals from the site are further characterized by comparing the critical toxicity values (i.e., AIC, AIS) (Table 4-2) to the estimated potential human intake values (Table 3-2). Anytime the estimated potential human intake value exceeds the applicable critical toxicity value (i.e., the ratio of the estimated potential human intake to the critical toxicity value exceeds 1.0) there may be a concern for potential human health risks under the specified exposure conditions. The calculated ratio values for individual chemicals, referred to as hazard indices, are calculated for potential subchronic and chronic exposures separately. The chemical-specific subchronic and chronic hazard indices are then summed to yield overall subchronic and chronic hazard indices. This assumption of additivity for multiple chemical exposures is consistent with EPA's risk assessment guidelines for chemical mixtures (USEPA 1986).

The total subchronic hazard index (i.e., sum of chemical-specific subchronic hazard indices) is 1.84×10^{-8} (Table 5-1). Note that this value represents the sum of the individual subchronic hazard indices for four of the 16 chemicals with potential noncarcinogenic effects and thus may underestimate the total subchronic risk from the site, though probably not significantly. There were no critical toxicity values available for comparison for the remaining 12 chemicals with noncarcinogenic effects, therefore, route specific intakes could not be calculated.

The total chronic hazard index is 1.37×10^{-8} . Note that this value represents the sum of individual chronic hazard indices for only 4 of the 16 chemicals with noncarcinogenic effects and may, as indicated above, underestimate the total chronic risk from the site.

Neither the total subchronic hazard index nor the total chronic hazard index exceed the threshold value of 1.0. Both values are significantly less than 1.0 and therefore, based on this analysis, there are no potential noncarcinogenic risks to public health from the existing contamination at the site.

TABLE 5-1 NONCARCINOGENICITY HAZARD INDICES

<u>Chemical</u>	<u>Hazard Index (Dimensionless)</u>	
	<u>Subchronic</u>	<u>Chronic</u>
Ethylbenzene	7.5×10^{-10}	2.0×10^{-9}
Mercury	1.73×10^{-8}	1.16×10^{-8}
Toluene	3.95×10^{-10}	1.37×10^{-10}
Zinc	9.38×10^{-12}	4.70×10^{-12}
Total	1.84×10^{-8}	1.37×10^{-8}

Because of the very low estimated concentrations of contaminants in Town Lake from the Phase II site, any potentially unaccounted for noncarcinogenic risk associated with the 12 contaminants for which AISs and AICs are not available is not considered significant.

5.2 Carcinogenic Risk Characterization

Risks from potential carcinogens are estimated as probabilities of excess cancers as a result of potential exposure to chemicals from the site. The carcinogenic potency factor correlates estimated potential chronic human intake directly to incremental risk. The results of the risk characterization are expressed as upper-bound estimates of the potential carcinogenic risk for each exposure point.

The total upper-bound risk estimates from estimated exposure to potential carcinogens via the potential ingestion of contaminated fish is 7.0×10^{-8} (i.e., 7.0 excess cancers in 100 million people). This risk level is below the generally accepted range for total upper-bound excess cancer risk (1.0×10^{-4} to 1.0×10^{-7}) for acceptable remedial alternatives at Superfund hazardous waste site (USEPA 1986). Therefore, no additional remedial action needs to be taken at this site. This conclusion is based on the assumption that there will be no significant change in conditions at the site (i.e., no increase or decrease in contaminant load to the aquifer). In fact, the closure plan calls for removal of all contaminated material from the site within five years, thus significantly reducing the projected exposure duration. Additionally, inherent in this conclusion are several conservative assumptions which tend to generate worst-case estimates of risks (e.g., all fish ingested come from Town Lake; all contaminated ground water enters Town Lake, etc.).

6.0. UNCERTAINTIES

It was necessary to make a number of assumptions which contribute to the uncertainty associated with the proposed risk estimates. The most significant uncertainties, assumptions and data gaps associated with this evaluation are discussed below.

1. Exposure duration - The closure plan calls for removal of all contaminated material from the site within five years. The EPA ARARs and critical toxicity values used in this evaluation are based on an assumed lifetime (i.e., 70-year) exposure. Thus, the actual risk from an exposure of five years may be significantly less than the assumed lifetime exposure.
2. Characterization of exposed populations - The potentially exposed population should be more adequately characterized. Population characterization information is required to appropriately interpret the estimated risk levels. This information includes:
 - Number of people in families of anglers fishing in Town Lake and amount of potentially contaminated fish eaten by each family member.
 - Identification of sensitive indigenous aquatic species in Town Lake.
3. Environmental fate and transport - The estimate of exposure point concentrations does not take into account environmental fate and transport mechanisms which will act on the contaminants in Town Lake. A worst-case assumption is used which assumes all contaminants entering the lake are available indefinitely in the water column with no losses via additional downstream dilution or photolysis, biodegradation, hydrolysis, etc.
4. Cancer Potency Factors - The cancer potency factors used in this evaluation are based on a lifetime (i.e., 70-year) exposure period and do not accurately reflect the risk from a shorter (i.e., five-year) exposure period. The actual risks from a five-year exposure would be much less. Given adequate time and resources, more appropriate cancer potency factors could be estimated for use in this evaluation. Also, cancer risks estimates may be slightly underestimated because CPFs are available for only 3 of 16 contaminants of concern. This difference is not expected to be significant because of low estimated exposure concentrations and other uncertainty factors.
5. Noncarcinogenic hazards are slightly underestimated because AICs and AIs are available for only 4 of 16 contaminants.

7.0 CONCLUSIONS

The results of this evaluation indicate that, under the specified exposure conditions, calculated risk levels are considerably below generally acceptable levels and no additional remedial action is needed at this site. This conclusion is based on the finding that: No ARARs are exceeded, estimated subchronic and chronic intake levels for four contaminants are less than corresponding AISs and AICs and the estimated upper-bound cancer risk estimate for consumption of potentially contaminated fish in Town Lake is 7.0×10^{-8} , which is lower than the EPA's generally accepted range for excess cancer risk (1.0×10^{-4} to 1.0×10^{-7} (USEPA 1986)). Most of the uncertainties and assumptions discussed in Section 6.0 all tend to lead to an overestimate of potential risks. Therefore, these conclusions represent conservative (i.e., worst-case) estimates. The actual risks may be significantly less than the very low estimates presented here indicate.

8.0 REFERENCES

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